WHITNEY NASHVILLE WATER WORKS (PWS 6210020)
SOURCE WATER ASSESSMENT FINAL REPORT

February 20, 2003

State of Idaho
Department of Environmental Quality

Executive Summary

Under the Safe Drinking Water Act Amendments of 1996, all states are required by the U.S. Environmental Protection Agency (EPA) to assess every source of public drinking water for its relative sensitivity to contaminants regulated by the act. This assessment is based on a land use inventory of the designated assessment areas and sensitivity factors associated with the wells, the spring, and the aquifer characteristics.

This report, *Source Water Assessment for Whitney Nashville Water Works, Preston, Idaho*, describes the public water system (PWS), the boundaries of the zones of water contribution, and the associated potential contaminant sources located within these boundaries. This assessment should be used as a planning tool, taken into account with local knowledge and concerns, to develop and implement appropriate protection measures for this source. **The results should not be used as an absolute measure of risk and they should not be used to undermine public confidence in the water system.**

The Whitney Nashville Water Works PWS (# 6210020) is a community drinking water system located in Franklin County. The system includes four wells and one spring that provide drinking water to approximately 400 persons through 117 connections. Well #1, the oldest of the wells, was drilled in 1960 and is located approximately three miles southeast of Preston between two irrigation ditches. It provides an average of 50,400 gallons per day (gpd) of water to the system. Well #2, located near Well #1, was drilled in 1962 and provides an average of 57,600 gpd of water to the system. Well #3 (also known as Foster's Well), located approximately one mile south of Well # 1 and approximately one mile east of Whitney, was drilled in 1976. It provides an average of 230,400 gpd of water to the system. The Pendleton Well is the newest source of drinking water for the system, drilled in 1997. It is located approximately 4 miles southeast of Preston and about one-half mile southeast of Well #1 and Well #2. It provides an average of 172,800 gpd of water to the drinking water system. The spring is located about one mile north of Well #1 and Well #2 and approximately one-half mile south of the Lamont and Johnson reservoirs. The spring was developed in 1917. The average production is unknown.

Water from the system is stored in two reservoirs: an aboveground, rectangular shaped, concrete, 130,000-gallon storage tank that is fed by the spring; and a new, buried, 300,000-gallon, circular shaped, reinforced concrete reservoir that is fed by the Pendleton Well. The spring water is treated manually by adding one gallon of sodium hypochlorite (11.5% concentrate) to 50 gallons of water in a solution tank every four days. The mixture is injected into the line from the spring just before entering the rectangular reservoir.

The potential contaminant sources within the delineation capture zones of the wells and the spring of the Whitney Nashville Water Works include former dairy sites, underground storage tank (UST) sites, leaking underground storage tank (LUST) sites, a paint store, a National Pollution Discharge Elimination System (NPDES) site, a roofing business, a plastics manufacturer, U.S. Route 91, some unimproved roads, and the Johnson and Lamont reservoirs. If an accidental spill or release occurred at or in any of these contaminant sources, inorganic chemical (IOC) contaminants, volatile organic chemical (VOC) contaminants, synthetic organic chemical (SOC) contaminants, or microbial contaminants could be added to the aquifer systems.

Final well susceptibility scores are derived from equally weighting potential contaminant inventory/land use scores and adding them with hydrologic sensitivity and system construction scores. Similarly, final spring susceptibility scores are derived from heavily weighting potential contaminant inventory/land use scores and adding them with system construction scores. Therefore, a low rating in one category coupled with a higher rating in the another category results in a final rating of low, moderate, or high susceptibility. Potential contaminants are divided into four categories: IOCs (e.g., nitrates, arsenic), VOCs (e.g., petroleum products), SOCs (e.g., pesticides), and microbial contaminants (e.g., bacteria). As a well or spring can be subject to various contamination settings, separate scores are given for each type of contaminant.

For the assessment, a review of laboratory tests was conducted using the State Drinking Water Information System (SDWIS). Repeat detections of total coliform bacteria and E.coli bacteria at the spring were recorded in April 1995. There have been detections of total coliform bacteria in the distribution system from June 1994 to November 1999, with repeat detections in June 1994 and September 1996. E.coli bacteria have also been detected in the distribution system in July 1994 and September 1997, with no repeat detections. In September 1996, fecal coliform bacteria were detected in the distribution system. However, the detection was not repeated.

Based on SDWIS, no SOCs or VOCs have been detected in the drinking water. The IOC fluoride has been detected in the all of the wells and the spring water but at concentrations below the maximum contaminant level (MCL) for the chemical, as established by the EPA. Traces of nitrate have been detected in Well #1, Well #2, and the Pendleton Well.

Nitrate has been detected in the spring at concentrations of 5.9 milligrams per liter (mg/L) in June 1998 and at 6.8 mg/L in June 1999, levels greater than one-half the current MCL of 10 mg/L. Arsenic has been detected in the spring at 0.0053 mg/L, a level greater than half the recently revised MCL of 0.010 mg/L. In October 2001, the EPA reduced the arsenic MCL from 0.050 mg/L to 0.010 mg/L, giving PWSs until 2006 to meet the new requirement. EPA requires reporting to the Consumer Confidence Report (CCR) any regulated compound detected in a PWS if concentrations of detected compounds are greater than half their MCL. Further information and health side effects can be researched at http://www.epa.gov/safewater/ccr1.html.

Alpha and beta particles (radionuclides) have been detected in the water of the spring, the Pendleton well, and in the distribution system. The alpha particle level detected in the spring has been as high as 12.1 picocuries per liter (pCi/L) in August 2001, greater than half the current MCL of 15 pCi/L. Beta particles have also been high in all of the wells and the spring at levels around 6 to 7 millirem (mrem) per year. Additionally, in December 2001, traces of uranium were detected in the spring. Radionuclides usually occur naturally in water. According to the Agency for Toxic Substances and Disease Registry (ATSDR), long-term exposure can lead to cancer.

In the April 2000 sanitary survey, it is noted that the spring appeared to be influenced by surface water. To determine if the spring was indeed influenced by surface water, the Whitney Nashville Water Works performed two Microscopic Particulate Analyses (MPAs) at the spring source. One MPA was performed on April 23, 2001 during a period of high water table and the other MPA was performed on October 10, 2001 during a period of low water table. Both samples were assigned a relative risk rating of zero. Using the criteria established in Idaho's Ground Water Under Direct Influence (GWUDI) evaluation procedure, the spring was considered ground water and not influenced by surface water. Therefore, in this report, the spring is assessed as ground water.

In terms of total susceptibility, all of the wells except for Well #3 (Foster's Well) and the spring rated moderate for VOCs and SOCs. Well #1, Well #2, and Well #3 rated high for IOCs and the Pendleton Well and the spring rated moderate for IOCs. Well # 2 and the spring automatically rated high for microbial contaminants. Well #1 and the Pendleton Well rated moderate for microbial contaminants. Well #3 rated high for all potential contaminant categories. Livestock within 30 feet of Well #2 resulted in an automatic high susceptibility rating for IOCs and microbial contaminants. A repeat detection of total coliform and E.coli bacteria at the spring resulted in an automatic high susceptibility score for microbial contaminants. Very little construction information was available for the wells and the spring, contributing to the high system construction scores of the drinking water system. The predominant land use in the area of the Whitney Nashville drinking water sources is undetermined agriculture, adding to the final susceptibility scores.

This assessment should be used as a basis for determining appropriate new protection measures or re-evaluating existing protection efforts. No matter what ranking a source receives, protection is always important. Whether the source is currently located in a "pristine" area or an area with numerous industrial and/or agricultural land uses that require surveillance, the way to ensure good water quality in the future is to act now to protect valuable water supply resources. If the system should need to expand in the future, new well or spring sites should be located in areas with as few potential sources of contamination as possible, and the site should be reserved and protected for this specific use.

An effective drinking water protection program is tailored to the particular local drinking water protection area. A community with a fully developed drinking water protection program will incorporate many strategies. For the Whitney Nashville Water Works, drinking water protection activities should first focus on correcting any deficiencies outlined in the sanitary survey (an inspection conducted every five years with the purpose of determining the physical condition of a water system's components and its capacity). The system should continue their efforts to keep the distribution system and the spring free of microbial contamination. The wells should be properly vented and the well seals should be maintained to avoid direct contamination of the source water. Additionally, a perimeter of at least 50 feet for the wells and 100 feet for the spring should be established to further protect the drinking water sources from contamination. If the area around Well #2 is restricted from livestock, the high microbial susceptibility score of the well would be reduced from high to moderate. The system may want to consider implementing engineering controls to reduce the level of nitrates, arsenic, and radionuclides detected in the spring. To meet the new arsenic standard, EPA (2002) recently released an issue paper entitled *Proven Alternatives for Aboveground Treatment of Arsenic in Ground water*.

As land uses within most of the source water assessment areas are outside the direct jurisdiction of the Whitney Nashville Water Works, collaboration and partnerships with state and local agencies and industry groups should be established and are critical to success. Providing state and local authorities with well logs for the wells and construction plans for the spring may assist them in determining the drinking water needs of the system. Educating city employees and the public about source water will further assist the system in its monitoring and protection efforts.

Due to the time involved with the movement of ground water, drinking water protection activities should be aimed at long-term management strategies even though these strategies may not yield results in the near term. A strong public education program should be a primary focus of any drinking water protection plan. Public education topics could include household hazardous waste disposal methods and the importance of water conservation. There are multiple resources available to help communities implement protection programs, including the Drinking Water Academy of the EPA. Drinking water protection activities for agriculture should be coordinated with the Idaho State Department of Agriculture, the Franklin County Soil and Water Conservation District, and the Natural Resources Conservation Service.

A community must incorporate a variety of strategies in order to develop a comprehensive drinking water protection plan, be they regulatory in nature (e.g. zoning, permitting) or non-regulatory in nature (e.g. good housekeeping, public education, specific best management practices). For assistance in developing protection strategies please contact the Pocatello Regional Office of the Idaho Department of Environmental Quality or the Idaho Rural Water Association.

SOURCE WATER ASSESSMENT FOR
WHITNEY NASHVILLE WATER WORKS, PRESTON, IDAHO

Section 1. Introduction – Basis for Assessment

The following sections contain information necessary to understand how and why this assessment was conducted. **It is important to review this information to understand what the ranking of this assessment means.** Maps showing the delineated source water assessment area and the inventory of significant potential sources of contamination identified within that area are included. The list of significant potential contaminant source categories and their rankings used to develop the assessment also is included.

Level of Accuracy and Purpose of the Assessment

The Idaho Department of Environmental Quality (DEQ) is required by the U.S. Environmental Protection Agency (EPA) to assess over 2,900 public drinking water sources in Idaho for their relative susceptibility to contaminants regulated by the Safe Drinking Water Act. This assessment is based on a land use inventory of the delineated assessment area, sensitivity factors associated with the wells and the spring, and aquifer characteristics. All assessments must be completed by May of 2003. The resources and time available to accomplish assessments are limited. Therefore, an in-depth, site-specific investigation to identify each significant potential source of contamination for every public water supply system is not possible. **This assessment should be used as a planning tool, taken into account with local knowledge and concerns, to develop and implement appropriate protection measures for this source. The results should <u>not be</u> used as an absolute measure of risk and they should <u>not be</u> used to undermine public confidence in the public water system (PWS).**

The ultimate goal of the assessment is to provide data to local communities to develop a protection strategy for their drinking water supply system. DEQ recognizes that pollution prevention activities generally require less time and money to implement than treatment of a public water supply system once it has been contaminated. DEQ encourages communities to balance resource protection with economic growth and development. The decision as to the amount and types of information necessary to develop a drinking water protection program should be determined by the local community based on its own needs and limitations. Wellhead or drinking water protection is one facet of a comprehensive growth plan, and it can complement ongoing local planning efforts.

Section 2. Conducting the Assessment

General Description of the Source Water Quality

The Whitney Nashville Water Works PWS (# 6210020) is a community drinking water system located in Franklin County (see Figure 1). The system includes four wells and one spring that provide drinking water to approximately 400 persons through 117 connections. Well #1, the oldest of the wells, was drilled in 1960 and is located approximately three miles southeast of Preston between two irrigation ditches. It provides an average of 50,400 gpd of water to the system. Well #2, located near Well #1, was drilled in 1962 and provides an average of 57,600 gpd of water to the system. Well #3 (also known as Foster's Well), located approximately one mile south of Well # 1 and approximately one mile east of Whitney was drilled in 1976. It provides an average of 230,400 gpd of water to the system. The Pendleton Well is the newest source of drinking water for the system, drilled in 1997. It is located approximately 4 miles southeast of Preston and about one-half mile southeast of Well #1 and Well #2. It provides an average of 172,800 gpd of water to the drinking water system. The spring is located about one mile north of Well #1 and Well #2 and approximately one-half mile south of the Lamont and Johnson reservoirs. The spring was developed in 1917. The average production is unknown.

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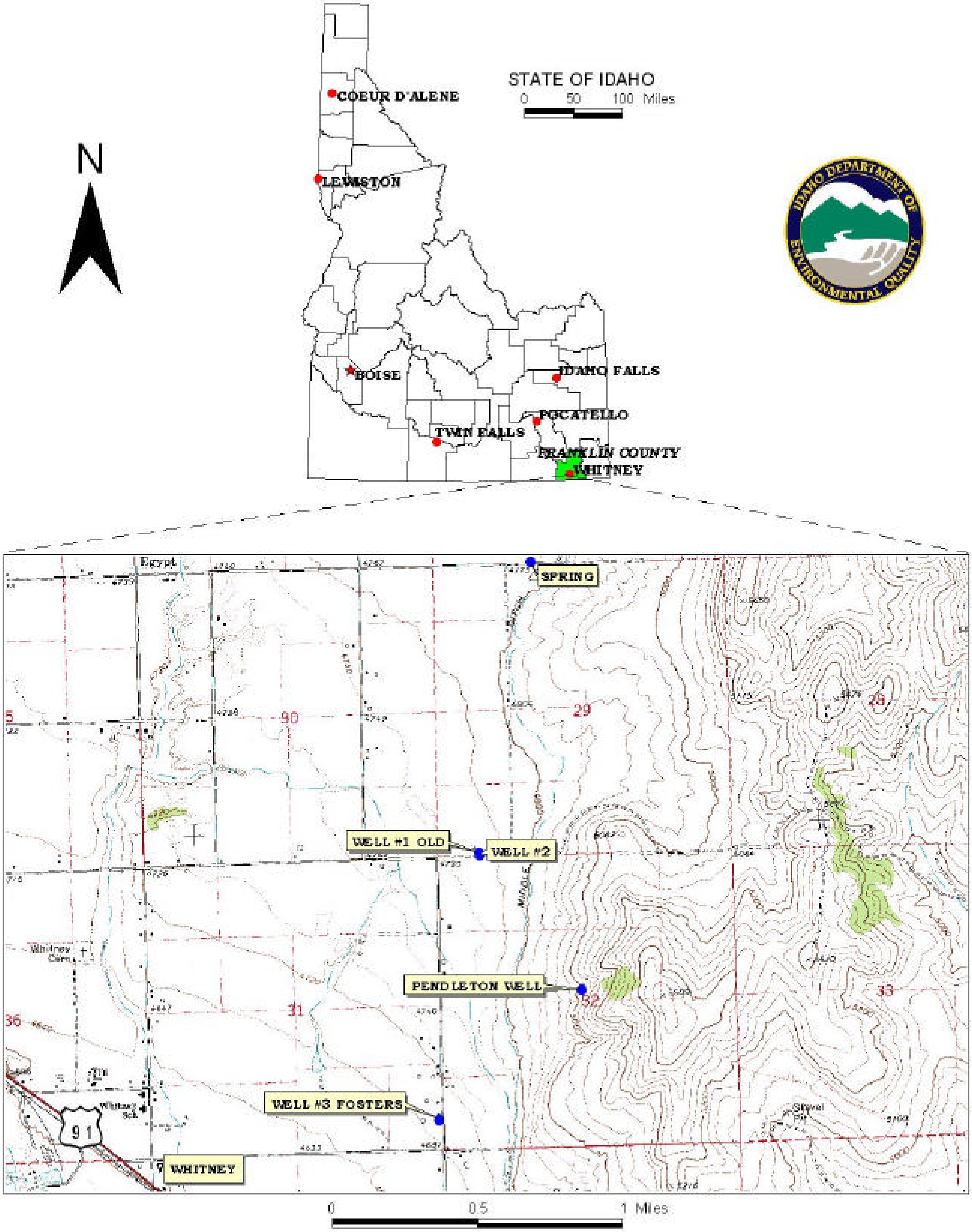
FIGURE 1. Geographic Location of Whitney Nashville Water Works



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Defining the Zones of Contribution – Delineation

The delineation process establishes the physical area around a well or a spring that will become the focal point of the assessment. The process includes mapping the boundaries of the zone of contribution into time-of-travel (TOT) zones (zones indicating the number of years necessary for a particle of water to reach a pumping well or a flowing spring) for water in the aquifer. Washington Group International (WGI) was contracted by DEQ to define the public water system's zones of contribution. WGI used a calculated fixed radius model approved by the Source Water Assessment Plan (DEQ, 1999) in determining the 3-year (Zone 1B), 6-year (Zone 2), and 10-year (Zone 3) TOT zones for the well water associated with the "Cache Valley" hydrologic province in the vicinity of the Whitney Nashville Water Works. WGI used a refined method in determining the 3-year (Zone 1B), 6-year (Zone 2), and 10-year (Zone 3) TOT zones for the spring water associated with the "None" hydrologic province. The computer model used site specific data, assimilated by WGI from a variety of sources including operator records and hydrogeologic reports. A summary of the hydrogeologic information from the WGI is provided below.

Cache Valley Hydrogeologic Conceptual Model

The Bear River Basin includes four hydrologic provinces within Idaho: Bear River – Dingle Swamp, Soda Springs, Gem Valley – Gentile Valley, and Cache Valley. The Bear River originates in the Uinta Mountains of northern Utah and winds its way through over 500 miles of Wyoming, Idaho, and Utah to terminate in a freshwater bay of the Great Salt Lake just 90 miles west of its source (Dion, 1969, p. 6). The Bear River enters Idaho near Border, Wyoming and flows along the north edge of the Bear River Plateau. Flowing north through the Bear River – Dingle Swamp hydrologic province, it passes into the Soda Springs hydrologic province east of the Bear River Range.

Upon entering the Gem Valley – Gentile Valley hydrologic province, it swings south. Now west of the Bear River Range, the river passes through the Oneida Narrows into the Cache Valley hydrologic province. Over most of its course through Idaho, the Bear River is gaining and in direct hydraulic communication with the major aquifer systems of the four hydrologic provinces. The exception is a small reach between the cities of Alexander and Grace where it is generally losing and is perched over the regional fractured basalt aquifer (Dion, 1969, p. 30).

Ground water in the Bear River Basin is found in Holocene alluvium, Pleistocene basalt, and rocks of the "Pliocene (?)" [sic] Salt Lake Formation, pre-Tertiary undifferentiated bedrock, and possibly the "Eocene (?)" [sic] Wasatch Formation (Dion, 1969, pp. 15 and 16). Rocks of the Salt Lake Formation, which include freshwater limestone, tuffaceous sandstone, rhyolite tuff and poorly-consolidated conglomerate, outcrop along the major valley margins and may underlie the valley-fill alluvium (Dion, 1969, pp. 16 and 17). Many of the wells drilled into this formation do not yield water. The few wells that do produce water yield as much as 1,800 gallons per minute (gal/min) from beds of sandstone and conglomerate.

The Wasatch Formation is restricted to the Bear Lake Plateau and small areas northwest of Bear Lake (Dion, 1969, p. 17). The formation is composed largely of tightly cemented conglomerate and sandstone with smaller amounts of shale, limestone, and tuff. The primary pore space is typically impermeable. Water movement may occur through joints and fractures or more permeable zones that are thought to exist along the relatively flat-lying formation (Dion, 1969, p. 17). Springs occur at the margins of the formation.

Precipitation in the basin ranges from 10 inches per year (in./yr) on the floor of Bear Lake Valley to over 45 in./yr on the Bear River Range (Dion, 1969, pp. Vll and 11). Applied over the entire basin, precipitation amounts to approximately 2.3 million acre-feet annually. Precipitation is also the principal source of recharge to the basin's aquifers in conjunction with spring snowmelt and runoff, irrigation seepage, and canal losses.

Natural ground water discharge is by flow to the Bear River, springs, seeps along river banks, and evapotranspiration in large marshy areas (Dion, 1969, p. VIII). Some discharge may also occur by way of underflow to the Portneuf River drainage through basalt flows at Tenmile pass and near Soda Point.

Ground water is obtained from both springs and wells in the Bear River Basin. Hundreds of springs issue primarily from fractures and solution openings in the bedrock on the margins of the basin (Dion, 1969, p. 47). Water production from wells in the four hydrologic provinces is primarily from alluvial and basalt aquifers; however, some wells tap conglomerate, sandstone, limestone and shale aquifers of the Salt Lake and possibly the Wasatch formations (Dion, 1969, p. VII).

Cache Valley is a complex graben covering about 310 square miles in southeastern Idaho and 350 square miles in northeastern Utah. It was once a bay of ancient Lake Bonneville resulting in lake terraces along the margins of the valley (Dion, 1969, p. 7). The related topographic features and deposits of ancient lakes affect the occurrence and movement of ground water (Bjorklund and McGreevy, 1971, p. 14).

The valley floor consists of unconsolidated valley-fill sediments of Quaternary age from the former Lake Bonneville and older lakes and streams, as well as younger alluvium. The sediments consist of silts and gravel of the Alpine and Bonneville formations, overlain by interfingering beds of gravel, sand, silt, and clay. Alluvial fan and landslide deposits are exposed along the margins of the valley. There is a general coarsening of sediments from lower elevations in the center of the valley to the higher elevations at the valley margins (Johnson et al., 1996). The surrounding mountain ranges consist of highly faulted Tertiary Salt Lake and "Wasatch (?)" [sic] formation rocks and Permian through Precambrian rocks (Bjorklund and McGreevy, 1971, Plate 1).

The major aquifers are composed of sand and gravel in fans and deltas; interbedded layers of lake-bottom clays and silts confine the aquifers and cause artesian conditions throughout the valley (Bjorklund and McGreevy, 1971, p.14). Deltas and fans from streams entering the valley generally contain a high percentage of gravel and are considered good aquifers (Bjorklund and McGreevy, 1971, p.15). The exception is the Bear River delta, which is composed mostly of fine sand and silt and contains poor aquifers.

Aquifer recharge occurs mainly by infiltration of water from precipitation, streams, canals, ditches, and irrigated lands and by subsurface inflow. A large volume of recharge originates in the Bear River Range where 30 to 50 inches of precipitation fall in most years. Average annual precipitation on the valley floor is approximately 15.5 inches (Bjorklund and McGreevy, 1971, pp. 5 and 18). The principal recharge area is along the margins of the valley that are underlain by permeable unconsolidated materials (Bjorklund and McGreevy, 1971, p. 18). In the lower parts of the valley, some water is recharged to shallow unconfined aquifers, but infiltrated water does not reach the confined aquifers in Idaho because of the upward artesian gradient.

Ground water is discharged by springs, seeps, drains, evapotranspiration, and wells. Many streams in Cache Valley originate at springs and seeps within the valley, and other streams gain in flow as they traverse the valley floor. Potentiometric levels range in elevation from about 4,850 ft msl near Oxford to about 4,500 feet near the Idaho-Utah border. Generally, the ground water flow direction is locally toward the Bear River and regionally south toward Utah. The Bear River in the Idaho part of Cache Valley is gaining (Bjorklund and McGreevy, 1971, p. 19).

Artesian conditions exist in a large part of the lower valley. Heads of most flowing wells are less than 40 feet above land surface, but heads as high as 62 feet above land surface have been measured (Bjorklund and McGreevy, 1971, p. 22). Water table conditions exist near the edge of the valley beneath alluvial slopes and benchlands. The depth to water is as much as 300 ft-bgs along the margin of the upper valley.

Most wells in the valley produce water from the unconsolidated basin deposits. Driller's logs indicate that the alluvium may contain several aquifers separated by silt and clay (Dion, 1969, p. 19). The most productive aquifer systems in the Idaho part of Cache Valley are in the area of Weston Creek and in fan deposits along the north and west sides of the valley. Aquifer tests near Weston indicate an average transmissivity of about 30,000 square feet per day (ft2/day) (Bjorklund and McGreevy, 1971, p. 2).

Transmissivity values of 5,000 and 40,000 ft2/day were reported from two tests conducted north of Clifton, Idaho (Johnson et al., 1996, p. 21). For a computer-aided analysis of the resulting test data, the contact at the valley margin was conceptualized as a low-permeability boundary and simulated as a no-flow boundary (Johnson et al., 1996, p .11). All of the Cache Valley PWS wells addressed in this report are located within a couple of miles of the bedrock/valley-fill contact or other near-surface geologic contact.

None Hydrogeologic Conceptual Model

Graham and Campbell (1981) identified and described 70 regional ground water systems throughout Idaho. Thirty-four of these fall within the southeastern part of the state. The “None” hydrologic province, as defined in this report, includes all the area outside of the 34 regional systems in southeast Idaho. The smaller and more localized aquifers in the “None” province typically are situated in the foothills and mountains that surround and recharge the regional ground water systems.

The mountains and valleys within the “None” hydrologic province were formed during two events separated by approximately 50 to 70 million years (Alt and Hyndman, 1989, pp. 329 and 336). The overthrust belt of the northern Rocky Mountains was formed through the intrusion of granitic magma and a massive eastward movement of large slabs of layered sedimentary rocks along faults that dip shallowly westward (Alt and Hyndman, 1989, p. 329). This movement caused extreme folding and fracturing of the sedimentary and granitic rocks and, in many cases, left older formations lying on top of younger ones. Later Basin and Range block faulting broke up the largely eroded Rocky Mountains into large uplifted and downthrown blocks resulting in the present day northwest trending mountains and valleys seen throughout southeast Idaho. Paleozoic and Precambrian limestone, dolomite, sandstone, shale, siltstone, and quartzite are the predominant materials forming the mountains and probably compose the bedrock underlying the valleys between Salmon, Idaho on the north side of the Snake River Plain and Franklin, Idaho near the Utah/Idaho border (Dion, 1969, p.18; Kariya et al., 1994, p. 6; Bjorklund and McGreevy, 1971, p. 12; and Parliman, 1982, p. 9).

Ground water movement in the mountains is primarily through a system of solution channels, fractures and joints that commonly transmit water independently of surface topography (Bjorklund and McGreevy, 1971, p. 15; Dion, 1969, p. 18). Ralston and others (1979, pp. 128-129) state that the geologic structural features also can contribute to the development of cross-basin ground water flow systems. Ground water entering a geologic formation tends to follow the formation because hydraulic conductivities are greater parallel to the bedding planes than across them. Synclines and anticlines provide structural avenues for ground water flow under ridges from one valley to another.

The average annual precipitation in the mountains of southeast Idaho ranges from 20 inches on ridges near Soda Springs to over 45 inches on the Bear River Range (Ralston and Trihey, 1975, p. 7, and Dion, 1969, p. 11). The valleys receive an average of 7 to 10 inches annually (Donato, 1998, p. 3, and Dion, 1969, p. 11). Precipitation and seepage from streams are the primary source of recharge to the mountain aquifers (Kariya, et al., 1994, p. 18, and Parliman, 1982, p. 13).

Ground water discharge occurs as springs and seeps issuing from faults, fractures, and solution channels and as underflow to regional aquifers. The Bear River Basin in the far southeast corner of the state contains hundreds of springs issuing primarily from fractures and solution openings in the bedrock mountains (Dion, 1969, p. 47, and Bjorklund and McGreevy, 1971, pp. 34-35). Within Cache Valley many springs discharge from the valley-fill deposits (Kariya et al., 1994, p. 32).

There is little available information on the distribution of hydraulic head and the hydraulic properties of the aquifers in the "None" hydrologic province. No U.S. Geological Survey (2001) or Idaho Statewide Monitoring Network (Neely, 2001) wells are located in the areas of concern to provide information on ground water flow direction and hydraulic gradient or to aid in model calibration. The information that is available indicates that the hydraulic properties are quite variable, even within a specific rock type. Ralston and others (1979, p. 31), for example, present hydraulic conductivity estimates for fractured chert ranging from 2.2 to 75 feet per day (ft/day). Estimates for phosphatic shale are as low as 0.07 ft/day (unfractured) and as high as 25 ft/day (fractured).

Springs and Spring Delineation Methods

A spring is defined as a concentrated discharge of ground water appearing at the ground surface as flowing water (Todd, 1980). The discharge of a spring depends on the hydraulic conductivity of the aquifer, the area of contributing recharge to the aquifer, and the rate of aquifer recharge. PWS springs are generally perennial. Large seasonal changes in the discharge rates are an indication of a relatively shallow flow system. While most springs fluctuate in their rate of discharge, springs in volcanic rock (e.g., basalt) are noted for their nearly constant discharge (Todd, 1980).

Delineation of the drinking water protection area for a spring involves special consideration. Hydrogeologic setting is foremost among the factors that control the shape and extent of the capture zone. A spring resulting from the presence of a high permeability fracture extending to great depth will have a much different capture zone than a depression spring formed where the ground surface intersects the water table in a unconsolidated aquifer.

Refined Method: Uniform Flow Option

The refined method (using the uniform flow option in WhAEM) was used for springs that generally lacked hydrologic data but had a reasonable basis for predicting ground water flow direction and were located outside previously simulated flow domains. The uniform flow option of WhAEM (Kraemer et al., 2000) was used to delineate the Whitney Nashville Water Works spring.

For the uniform flow model it is assumed that the PWS spring issues from sedimentary rock, due to the prevalence of this material throughout the mountains of southern Idaho. For this reason, the hydraulic conductivity, effective porosity, and hydraulic gradient used in the models are the default values presented in Table F-3 of the Idaho Wellhead Protection Plan for mixed volcanic and sedimentary rocks, primarily sedimentary rocks (IDEQ, 1997, p. F-6). The average discharge rate for PWS springs that had reliable discharge data (563,000 gal/day) was used in the source area delineation for the Whitney Nashville spring . The average discharge rates reported by the owner/operator or the State of Idaho Public Water Supply Inventory Form were used for the remaining springs. A base elevation of 0 ft-msl was used to simplify the modeling process and had no impact on the size or shape of the resulting source areas. To maintain conservatism, no areal recharge was applied in any of the uniform flow simulations.

Calculated Fixed Radius Method

The calculated fixed-radius method was used for all of the Whitney Nashville wells. The fixed radii for the 3-, 6-, and 10-year capture zones were calculated using equations presented by Keely and Tsang (1983) for the velocity distribution surrounding a pumping well.

These wells are completed or assumed completed in either unconsolidated alluvium or conglomerate based on well location and completion depths. The hydraulic conductivity for alluvial wells (112 ft/day) is the geometric mean of pump test-derived estimates presented by Bjorklund and McGreevy (1971, Table 5). The hydraulic conductivity for conglomerate wells (14 ft/day) is based on analysis of specific capacity data from Dayton City Well #2 using the method of Walton (1962, p. 12). The effective porosities (0.3 and 0.2) and uniform hydraulic gradients (0.01 and 0.003) are the default values presented in Table F-3 of the Idaho Wellhead Protection Plan for unconsolidated alluvium and mixed volcanic and sedimentary rocks primarily sedimentary rocks, respectively (IDEQ, 1997, p. F-6).

The aquifer thickness is the saturated open interval of each well. For wells lacking these data, the aquifer thickness was assigned a value based on other PWS wells completed in the same aquifer. The hydraulic gradients used in the fixed-radius calculations are the default values presented in Table F-3 of the Idaho Wellhead Protection Plan for unconsolidated alluvium and mixed volcanic and sedimentary rocks, primarily sedimentary rocks (IDEQ, 1997, p. F-6).

The delineated source water assessment area for the Whitney Nashville Water Works wells can be described as three concentric circles and the delineation area for the Whitney Nashville spring is also three circles of varying diameters (see Figures 2, 3, 4, 5, and 6). Table 1 below includes the diameters of each TOT zone for each source. The actual data used by WGI in determining the source water assessment delineation area is available from DEQ upon request.

Table 1. Whitney Nashville Water Works Delineated Area Summary

Source	3-year TOT Diameter (ft)	6-year TOT Diameter (ft)	10-year TOT diameter (ft)
Well #1 Old	4,234	8,344	13,813
Well #2	4,251	8,363	13,834
Well #3	1,427	2,114	2,855
Pendleton Well	1,653	2,433	3,265
Spring	*900	*1,350	*1,850

[1] TOT = time-of-travel (in years) for a potential contaminant to reach the wellhead

*** = Approximate values**

Identifying Potential Sources of Contamination

A potential source of contamination is defined as any facility or activity that stores, uses, or produces, as a product or by-product, the contaminants regulated under the Safe Drinking Water Act. Furthermore, these sources have a sufficient likelihood of releasing such contaminants into the environment at levels that could pose a concern relative to drinking water sources. The goal of the inventory process is to locate and describe those facilities, land uses, and environmental conditions that are potential sources of ground water contamination. Field surveys conducted by DEQ and reviews of available databases identified potential contaminant sources within the delineated areas.

It is important to understand that a release may never occur from a potential source of contamination provided they are using best management practices. Many potential sources of contamination are regulated at the federal level, state level, or both, to reduce the risk of release. Therefore, when a business, facility, or property is identified as a potential contaminant source, this should not be interpreted to mean that this business, facility, or property is in violation of any local, state, or federal environmental law or regulation. What it does mean is that the potential for contamination exists due to the nature of the business, industry, or operation. There are a number of methods that water systems can use to work cooperatively with potential sources of contamination, including educational visits and inspections of stored materials. Many owners of such facilities may not even be aware that they are located near a public water supply source.

Contaminant Source Inventory Process

A two-phased contaminant inventory of the study area was conducted in 2002. The first phase involved identifying and documenting potential contaminant sources within the Whitney Nashville Water Works source water assessment areas through the use of computer databases and Geographic Information System (GIS) maps developed by DEQ. The second, or enhanced, phase of the contaminant inventory involved contacting the operator to identify and add any additional potential sources in the delineated areas. When the enhanced inventory was conducted (August 2002), there was no response from the operator, and no additional potential contaminant sources were incorporated into the assessment. Maps with the well and spring locations, delineated areas, and potential contaminant sources are provided with this report (see Figures 2, 3, 4, 5, and 6 in Appendix A and Tables 3, 4, 5, 6 and 7 in Appendix B).

Section 3. Susceptibility Analyses

A well's susceptibility to contamination is ranked as high, moderate, or low risk according to the following considerations: hydrologic sensitivity, construction, land use characteristics, and potentially significant contaminant sources. A spring's susceptibility is ranked similarly except it does not consider hydrologic sensitivity. The susceptibility rankings are specific to a particular potential contaminant or category of contaminants. Therefore, a high susceptibility rating relative to one potential contaminant does not mean that the water system is at the same risk for all other potential contaminants. The relative ranking that is derived for the well or spring is a qualitative, screening-level step that, in many cases, uses generalized assumptions and best professional judgement. Appendix C contains the susceptibility analysis worksheet. The following summaries describe the rationale for the susceptibility ranking.

Hydrologic Sensitivity

The hydrologic sensitivity of a well is dependent upon four factors: surface soil composition, the material in the vadose zone (between the land surface and the water table), the depth to first ground water, and the presence of a 50-foot thick fine-grained zone (aquitard) above the producing zone of the well. Slowly draining soils such as silt and clay typically are more protective of ground water than coarse-grained soils such as sand and gravel. Similarly, fine-grained sediments in the subsurface and a water depth of more than 300 feet protect the ground water from contamination.

Hydrologic sensitivity was rated moderate for all of the Whitney Nashville wells (Table 2). This is based on poor to moderate drained soil classes defined by the National Resource Conservation Service (NRCS). Soils that have poor to moderate drainage characteristics have better filtration capabilities than faster draining soils. The well logs were unavailable, limiting the data to determine the composition of the vadose zones, the location of the producing zones, or the presence of fine-grained zones above the producing zones of the wells.

Well Construction

Well construction directly affects the ability of the well to protect the aquifer from contaminants. System construction scores are reduced when information shows that potential contaminants will have a more difficult time reaching the intake of the well. Lower scores imply a system is less vulnerable to contamination. For example, if the well casing and annular seal both extend into a low permeability unit, then the possibility of contamination is reduced and the system construction score goes down. If the highest production interval is more than 100 feet below the water table, then the system is considered to have better buffering capacity. If the wellhead and surface seal are maintained to standards, as outlined in sanitary surveys, then contamination down the well bore is less likely. If the well is protected from surface flooding and is outside the 100-year floodplain, then contamination from surface events is reduced.

The drinking water system for Whitney Nashville Water Works includes four ground water wells. Well #1 is the oldest well, drilled in 1960 to a depth of 171 feet below ground surface (bgs). It has a 12-inch diameter casing. Well #2 was drilled in 1962 to a depth of 140 feet bgs and it also has a 12-inch diameter casing. Well #3 (Fosters Well) was drilled in 1976 to a depth of 600 feet bgs and it has an 8-inch diameter casing. The Pendleton Well is the newest well, drilled in 1997 to a depth of 400 feet bgs. It has a 12-inch diameter casing.

The system construction scores for all of the wells were rated highly susceptible to contamination (Table 2). The 2000 sanitary survey indicates that all of the wellhead and surface seals are maintained to standards except for the wellhead seal on Well #3, which is deteriorated. Additionally, the sanitary survey indicates that none of the wellheads have a well casing vent. The purpose of the vent is to vent the space between the casing and the column and prevent a vacuum from forming when the well turns on and draws down the water table. A vacuum could draw in contamination through joints or leaks in the casing or cause the well to slough. The well logs for the Whitney Nashville Water Works wells were unavailable. When no information is available, a higher, more conservative, score is given.

The Idaho Department of Water Resources (IDWR) *Well Construction Standards Rules (1993)* require all public water systems to follow DEQ standards. IDAPA 58.01.08.550 requires that PWSs follow the *Recommended Standards for Water Works (1997)* during construction. Under current standards, all PWS wells are required to have a 50-foot buffer around the wellhead and if the well is designed to yield greater than 50 gallons per minute (gpm) a minimum of a 6-hour pump test is required. These standards are used to rate the system construction for the well by evaluating items such as condition of wellhead and surface seal, whether the casing and annular space is within consolidated material or 18 feet below the surface, the thickness of the casing, etc. If all criteria are not met, the public water source does not meet the IDWR Well Construction Standards. In this case, there was insufficient information available to determine if the wells meet all the criteria outlined in the IDWR Well Construction Standards.

Spring Construction

Spring construction scores are determined by evaluating whether the spring has been constructed according to Idaho Code (IDAPA 58.01.08.04) and if the spring's water is exposed to any potential contaminants from the time it exits the bedrock to when it enters the distribution system. If the spring's intake structure, infiltration gallery, and housing are located and constructed in such a manner as to be permanent and protect it from all potential contaminants, is contained within a fenced area of at least 100 feet in radius, and is protected from all surface water by diversions, berms, etc., then Idaho Code is being met and the score will be lower. If the spring's water comes in contact with the open atmosphere before it enters the distribution system, it receives a higher score. Likewise, if the spring's water is piped directly from the bedrock to the distribution system or is collected in a protected spring box without any contact to potential surface-related contaminants, the score is lower.

The Whitney Nashville spring rated high for system construction. The spring was developed in 1917 but based on the April 2000 sanitary survey (conducted by DEQ), there is limited information concerning the development of the spring. When no information is available, a higher, more conservative, score is given.

Potential Contaminant Source and Land Use

Well #1, Well #3, the Pendleton Well, and the spring rated moderately susceptible for IOCs (e.g., nitrates, arsenic), VOCs (e.g., petroleum products), SOCs (e.g., pesticides), and low for microbial contaminants (e.g., bacteria). Well #2 rated moderately susceptible for IOCs and low for VOCs, SOCs, and microbial contaminants. The undetermined agricultural land use of the area and the potential contaminant sources within the 3-year TOT zone contributed to the potential contaminant land use scores.

Final Susceptibility Ranking

A detection above a drinking water standard MCL, any detection of a VOC or SOC, or a confirmed microbial detection at the wellhead or the spring will automatically give a high susceptibility rating to the wells and/or the spring despite the land use of the area, because a pathway for contamination already exists. In this case, a repeat detection of total coliform and E.coli bacteria was recorded at the spring in 1995, resulting in an automatic high susceptibility score for microbial contaminants. Additionally, potential contaminant sources within 100 feet of a spring will automatically lead to a high susceptibility rating. According to the 2000 sanitary survey, livestock were within 30 feet of Well #2, resulting in an automatic high susceptibility score for IOCs and microbial contaminants. Having multiple potential contaminant sources in the 0- to 3-year time of travel zone (Zone 1B) contribute greatly to the overall ranking.

Table 2. Summary of Whitney Nashville Water Works Susceptibility Evaluation

Drinking Water Sources	Susceptibility Scores[1]									
	Hydrologic Sensitivity	Potential Contaminant Inventory and Land Use				System Construction	Final Susceptibility Ranking			
		IOC	VOC	SOC	Microbials		IOC	VOC	SOC	Microbials
Well #1	M	M	M	M	L	H	H	M	M	M
Well #2	M	M	L	L	L	H	H(*)	M	M	H*
Well #3	M	M	M	M	L	H	H	H	H	H
Pendleton Well	M	M	M	M	L	H	M	M	M	M
Spring	--	M	M	M	L	H	M	M	M	H*

[1]H = High Susceptibility, M = Moderate Susceptibility, L = Low Susceptibility,
IOC = inorganic chemical, VOC = volatile organic chemical, SOC = synthetic organic chemical
H(*) = Automatic high susceptibility due to livestock near Well #2 and a large number of points
H* = Automatic high susceptibility due to a repeat detection of total coliform and E.coli bacteria at the spring.

Susceptibility Summary

In terms of total susceptibility, all of the wells except Well #3 (Foster's Well) and the spring rated moderate for VOCs and SOCs. Well #1, Well #2, and Well #3 rated high for IOCs and the Pendleton Well and the spring rated moderate for IOCs. Well # 2 and the spring rated high for microbial contaminants. Well #1 and the Pendleton Well rated moderate for microbial contaminants. Well #3 rated high for all potential contaminant categories. Livestock within 30 feet of Well #2 resulted in an automatic high susceptibility rating for IOCs and microbial contaminants. A repeat detection of total coliform and E.coli bacteria at the spring resulted in an automatic high susceptibility score for microbial contaminants. Very little construction information was available for the wells and the spring, contributing to the high system construction scores of the drinking water system. The predominant land use in the area of the Whitney Nashville drinking water sources is undetermined agriculture, adding to the final susceptibility scores.

Repeat detections of total coliform bacteria and E.coli bacteria at the spring were recorded in April 1995. There have been detections of total coliform bacteria in the distribution system from June 1994 to November 1999, with repeat detections in June 1994 and September 1996. E.coli bacteria have also been detected in the distribution system in July 1994 and September 1997, with no repeat detections. In September 1996, fecal coliform bacteria were detected in the distribution system. However, the detection was not repeated.

Based on SDWIS, no SOCs or VOCs have been detected in the drinking water system. The IOC fluoride has been detected in the all of the wells and the spring water but at concentrations below the MCL for each chemical, as established by the EPA. Traces of nitrate have been detected in Well #1, Well #2, and the Pendleton Well.

Nitrate has been detected in the spring at concentrations of 5.9 mg/L in June 1998 and at 6.8 mg/L in June 1999, levels greater than one-half the current MCL of 10 mg/L. Arsenic has been detected in the spring at 0.0053 mg/L, a level greater than half the recently revised MCL of 0.010 mg/L. In October 2001, the EPA reduced the arsenic MCL from 0.050 mg/L to 0.010 mg/L, giving PWSs until 2006 to meet the new requirement. EPA requires reporting to the CCR any regulated compound detected in a PWS if concentrations of detected compounds are greater than half their MCL. Further information and health side effects can be researched at http://www.epa.gov/safewater/ccr1.html.

Alpha and beta particles (radionuclides) have been detected in the water of the spring, the Pendleton well, and in the distribution system. The alpha particle level detected in the spring has been as high as 12.1 pCi/L in August 2001, greater than half the current MCL of 12 pCi/L. Beta particles have also been high in all of the wells and the spring at levels around 6 to 7 mrem per year. Additionally, in December 2001, traces of uranium were detected in the spring. Radionuclides usually occur naturally in water. According to ATSDR, long-term exposure can lead to cancer.

Section 4. Options for Drinking Water Protection

This assessment should be used as a basis for determining appropriate new protection measures or re-evaluating existing protection efforts. No matter what ranking a source receives, protection is always important. Whether the source is currently located in a “pristine” area or an area with numerous industrial and/or agricultural land uses that require surveillance, the way to ensure good water quality in the future is to act now to protect valuable water supply resources. If the system should need to expand in the future, new well or spring sites should be located in areas with as few potential sources of contamination as possible, and the site should be reserved and protected for this specific use.

An effective drinking water protection program is tailored to the particular local drinking water protection area. A community with a fully developed drinking water protection program will incorporate many strategies. For the Whitney Nashville Water Works, drinking water protection activities should first focus on correcting any deficiencies outlined in the sanitary survey. The system should continue their efforts to keep the distribution system and the spring free of microbial contamination. The wells should be properly protected from surface flooding by assuring that each well casing extends at least 18 inches above the ground and that each well is properly vented. Additionally, a perimeter of at least 50 feet for the wells and 100 feet for the spring should be established to further protect the drinking water sources from contamination. If the area surrounding Well #2 is restricted from livestock, the susceptibility score for microbial contaminants will be reduced from high to moderate. The system may want to consider implementing engineering controls to reduce the level of nitrates, arsenic, and radionuclides detected in the spring.

As land uses within most of the source water assessment areas are outside the direct jurisdiction of the Whitney Nashville Water Works, collaboration and partnerships with state and local agencies and industry groups should be established and are critical to success. Providing state and local authorities with well logs for the wells and construction plans for the spring may assist them in determining the drinking water needs of the system. Educating city employees and the public about source water will further assist the system in its monitoring and protection efforts.

Due to the time involved with the movement of ground water, drinking water protection activities should be aimed at long-term management strategies even though these strategies may not yield results in the near term. A strong public education program should be a primary focus of any drinking water protection plan. Public education topics could include household hazardous waste disposal methods and the importance of water conservation. There are multiple resources available to help communities implement protection programs, including the Drinking Water Academy of the EPA. Drinking water protection activities for agriculture should be coordinated with the Idaho State Department of Agriculture, the Franklin County Soil Conservation and Water District, and the Natural Resources Conservation Service.

A community must incorporate a variety of strategies in order to develop a comprehensive drinking water protection plan, be they regulatory in nature (e.g. zoning, permitting) or non-regulatory in nature (e.g. good housekeeping, public education, specific best management practices). For assistance in developing protection strategies please contact the Pocatello Regional Office of the DEQ or the Idaho Rural Water Association.

Assistance

Public water supplies and others may call the following DEQ offices with questions about this assessment and to request assistance with developing and implementing a local protection plan. In addition, draft protection plans may be submitted to the DEQ office for preliminary review and comments.

Pocatello Regional DEQ Office (208) 236-6160

State DEQ Office (208) 373-0502

Website: http://www.deq.state.id.us

Water suppliers serving fewer than 10,000 persons may contact Melinda Harper (mlharper@idahoruralwater.com), Idaho Rural Water Association, at (208) 343-7001 for assistance with drinking water protection (formerly wellhead protection) strategies.

POTENTIAL CONTAMINANT INVENTORY LIST OF ACRONYMS AND DEFINITIONS

AST (Aboveground Storage Tanks) – Sites with aboveground storage tanks.

Business Mailing List – This list contains potential contaminant sites identified through a yellow pages database search of standard industry codes (SIC).

CERCLA – This includes sites considered for listing under the **Comprehensive Environmental Response Compensation and Liability Act (CERCLA)**. CERCLA, more commonly known as Superfund is designed to clean up hazardous waste sites that are on the national priority list (NPL).

Cyanide Site – DEQ permitted and known historical sites/facilities using cyanide.

Dairy – Sites included in the primary contaminant source inventory represent those facilities regulated by Idaho State Department of Agriculture (ISDA) and may range from a few head to several thousand head of milking cows.

Deep Injection Well – Injection wells regulated under the Idaho Department of Water Resources generally for the disposal of stormwater runoff or agricultural field drainage.

Enhanced Inventory – Enhanced inventory locations are potential contaminant source sites added by the water system. These can include new sites not captured during the primary contaminant inventory, or corrected locations for sites not properly located during the primary contaminant inventory. Enhanced inventory sites can also include miscellaneous sites added by the Idaho Department of Environmental Quality (DEQ) during the primary contaminant inventory.

Floodplain – This is a coverage of the 100-year floodplains.

Group 1 Sites – These are sites that show elevated levels of contaminants and are not within the priority one areas.

Inorganic Priority Area – Priority one areas where greater than 25% of the wells/springs show constituents higher than primary standards or other health standards.

Landfill – Areas of open and closed municipal and non-municipal landfills.

LUST (Leaking Underground Storage Tank) – Potential contaminant source sites associated with leaking underground storage tanks as regulated under RCRA.

Mines and Quarries – Mines and quarries permitted through the Idaho Department of Lands.)

Nitrate Priority Area – Area where greater than 25% of wells/springs show nitrate values above 5 mg/l.

NPDES (National Pollutant Discharge Elimination System) – Sites with NPDES permits. The Clean Water Act requires that any discharge of a pollutant to waters of the United States from a point source must be authorized by an NPDES permit.

Organic Priority Areas – These are any areas where greater than 25% of wells/springs show levels greater than 1% of the primary standard or other health standards.

Recharge Point – This includes active, proposed, and possible recharge sites on the Snake River Plain.

RCRA – Site regulated under **Resource Conservation Recovery Act (RCRA)**. RCRA is commonly associated with the cradle to grave management approach for generation, storage, and disposal of hazardous wastes.

SARA Tier II (Superfund Amendments and Reauthorization Act Tier II Facilities) – These sites store certain types and amounts of hazardous materials and must be identified under the Community Right to Know Act.

Toxic Release Inventory (TRI) – The toxic release inventory list was developed as part of the Emergency Planning and Community Right to Know (Community Right to Know) Act passed in 1986. The Community Right to Know Act requires the reporting of any release of a chemical found on the TRI list.

UST (Underground Storage Tank) – Potential contaminant source sites associated with underground storage tanks regulated as regulated under RCRA.

Wastewater Land Applications Sites – These are areas where the land application of municipal or industrial wastewater is permitted by DEQ.

Wellheads – These are drinking water well locations regulated under the Safe Drinking Water Act. They are not treated as potential contaminant sources.

NOTE: Many of the potential contaminant sources were located using a geocoding program where mailing addresses are used to locate a facility. Field verification of potential contaminant sources is an important element of an enhanced inventory.

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Appendix A

Delineation and Potential Contaminant Inventory Location Maps

Whitney Nashville Water Works

Figures 2, 3, 4, 5, and 6

FIGURE 2. Whitney Nashville Water Works Delineation Map and Potential Contaminant Source Locations

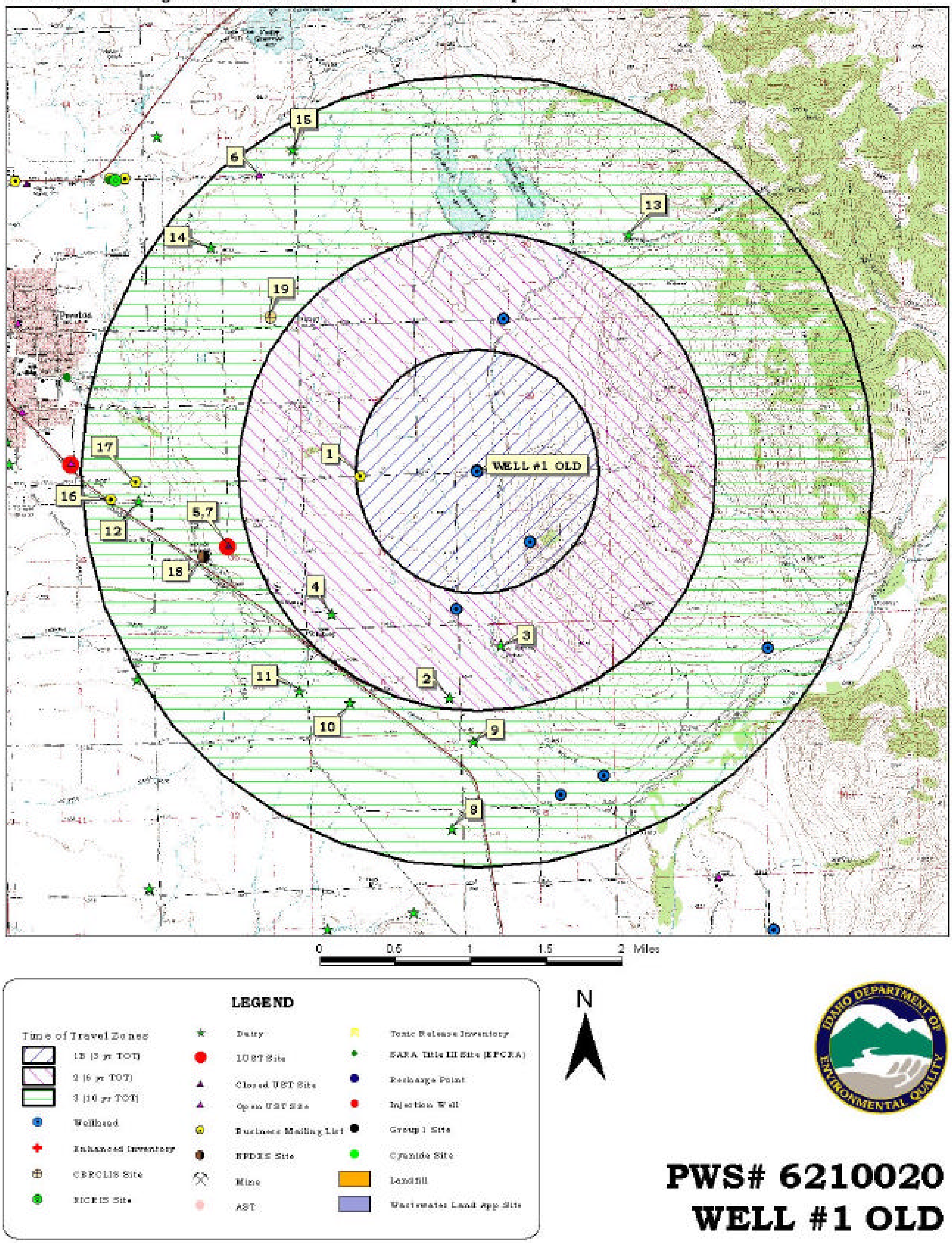
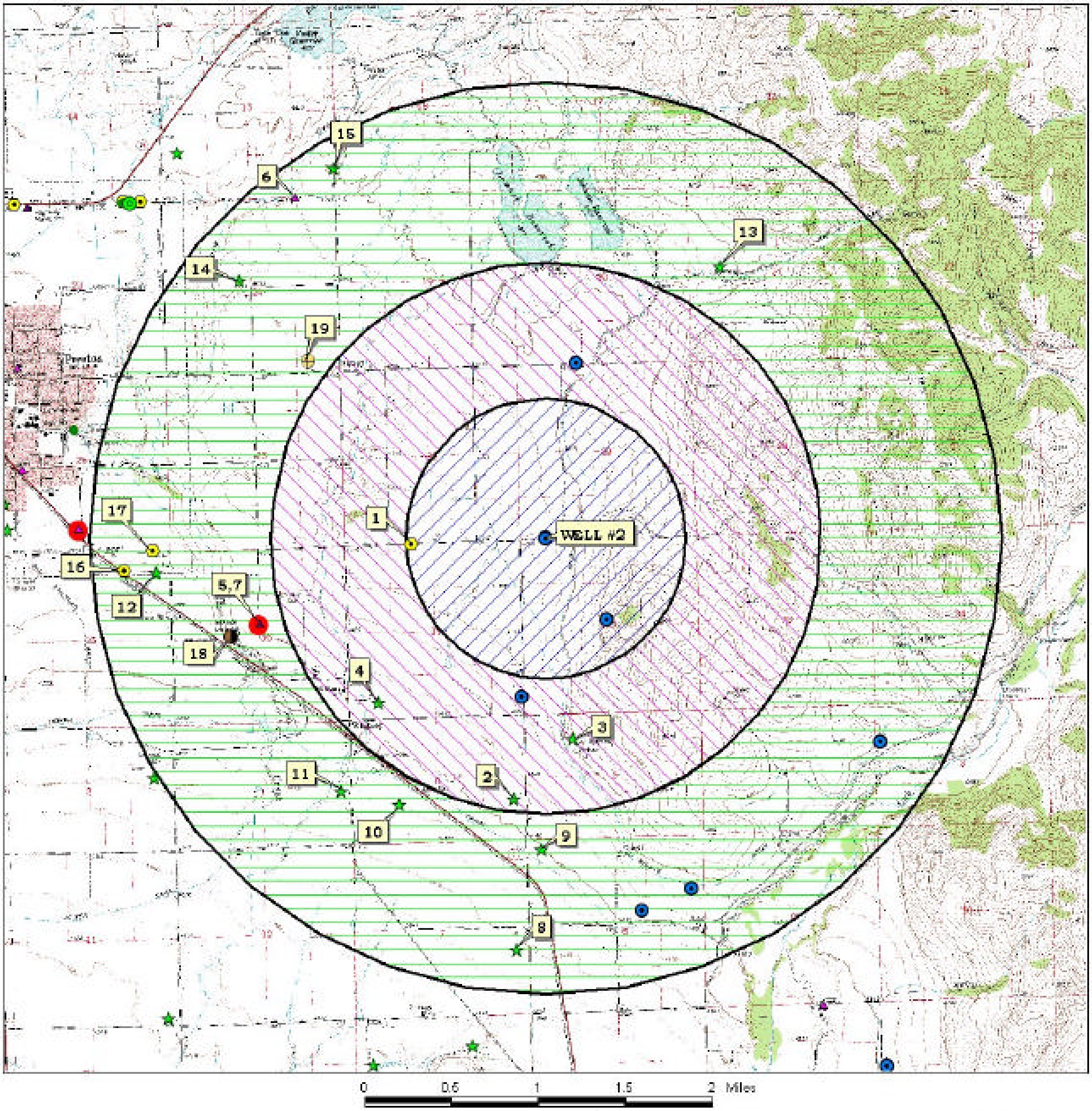
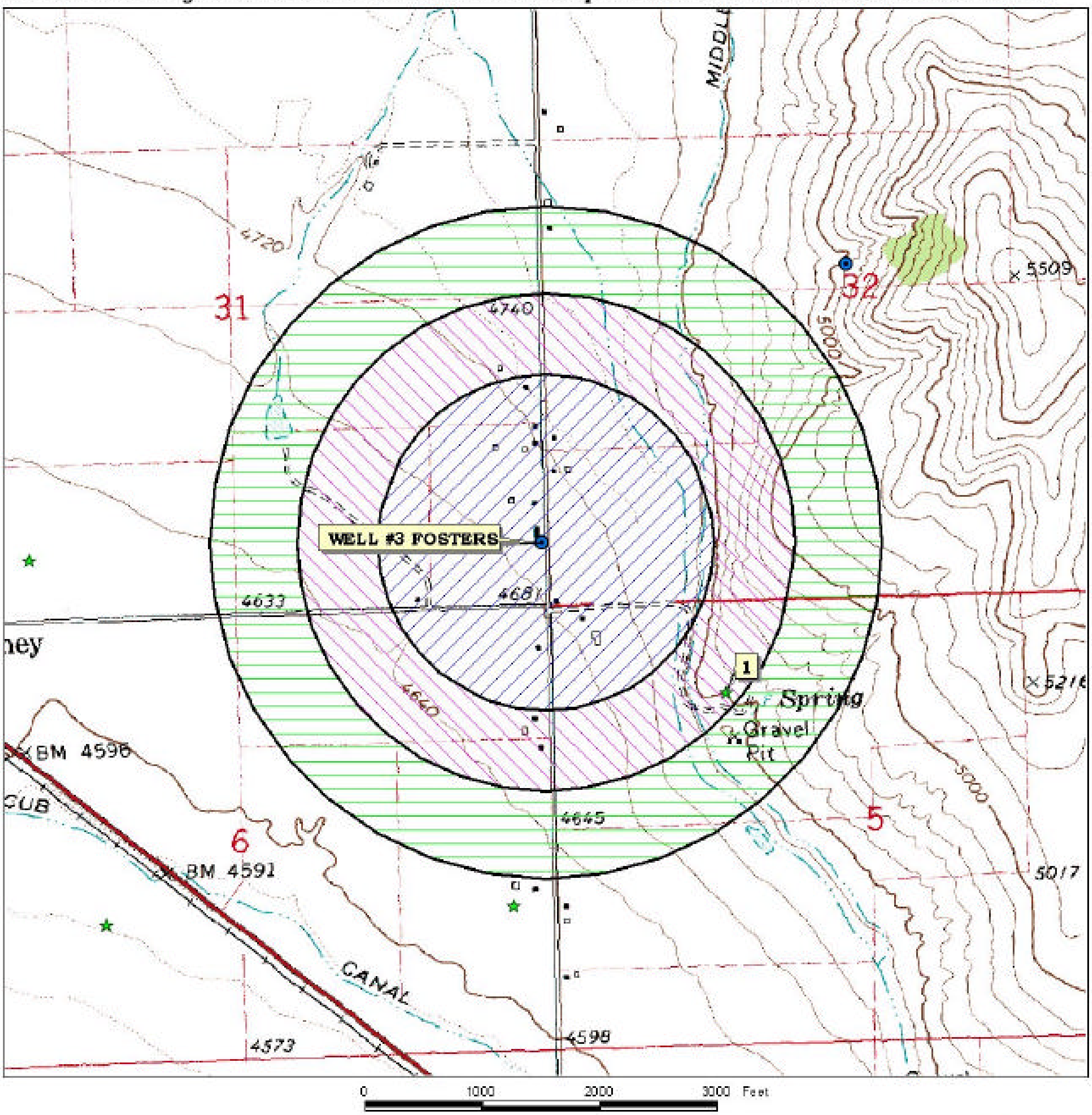


FIGURE 3. Whitney Nashville Water Works Delineation Map and Potential Contaminant Source Locations



PWS# 6210020
WELL #2

FIGURE 4. Whitney Nashville Water Works Delineation Map and Potential Contaminant Source Locations



N

PWS# 6210020
WELL #3 FOSTERS

FIGURE 5. Whitney Nashville Water Works Delineation Map and Potential Contaminant Source Locations

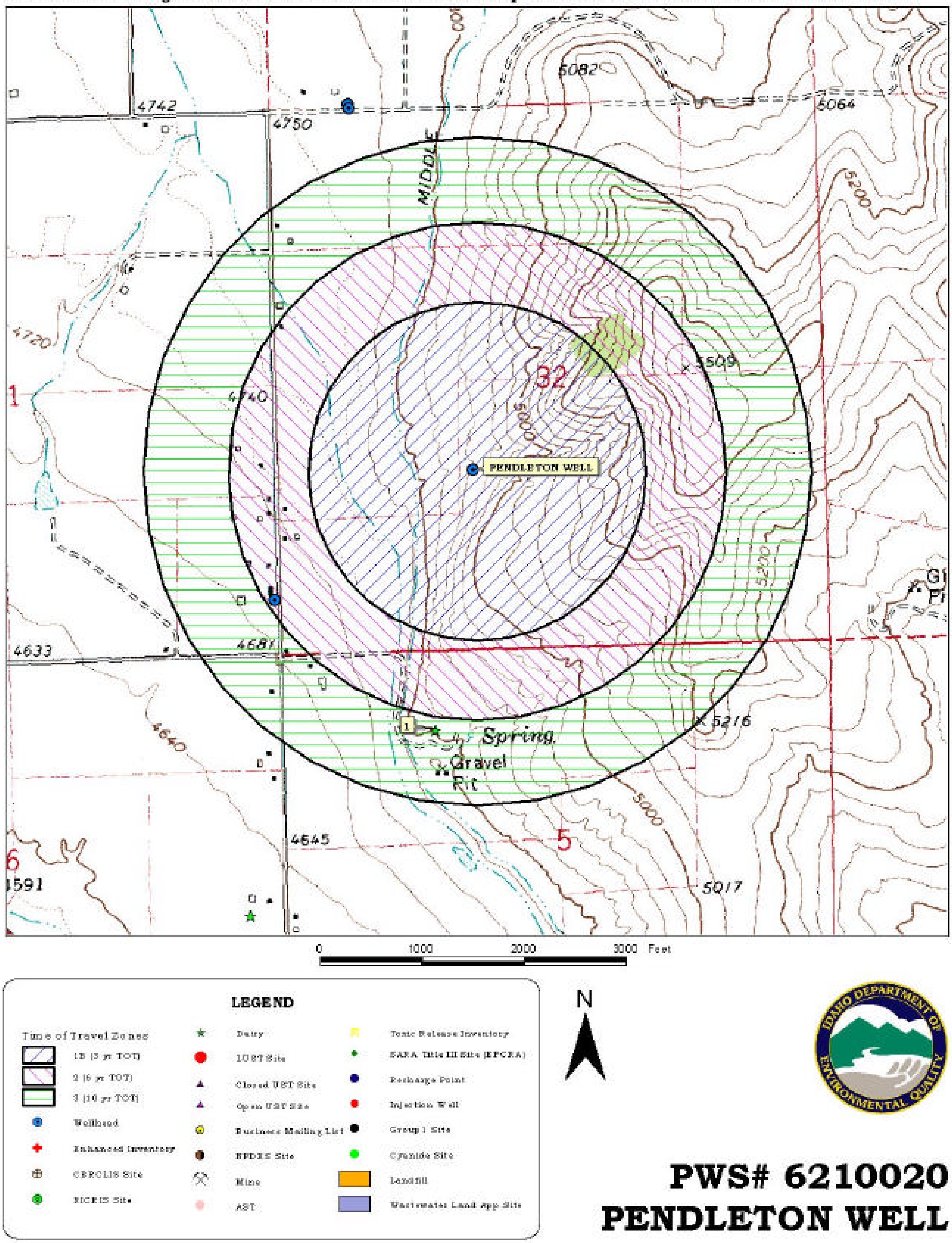
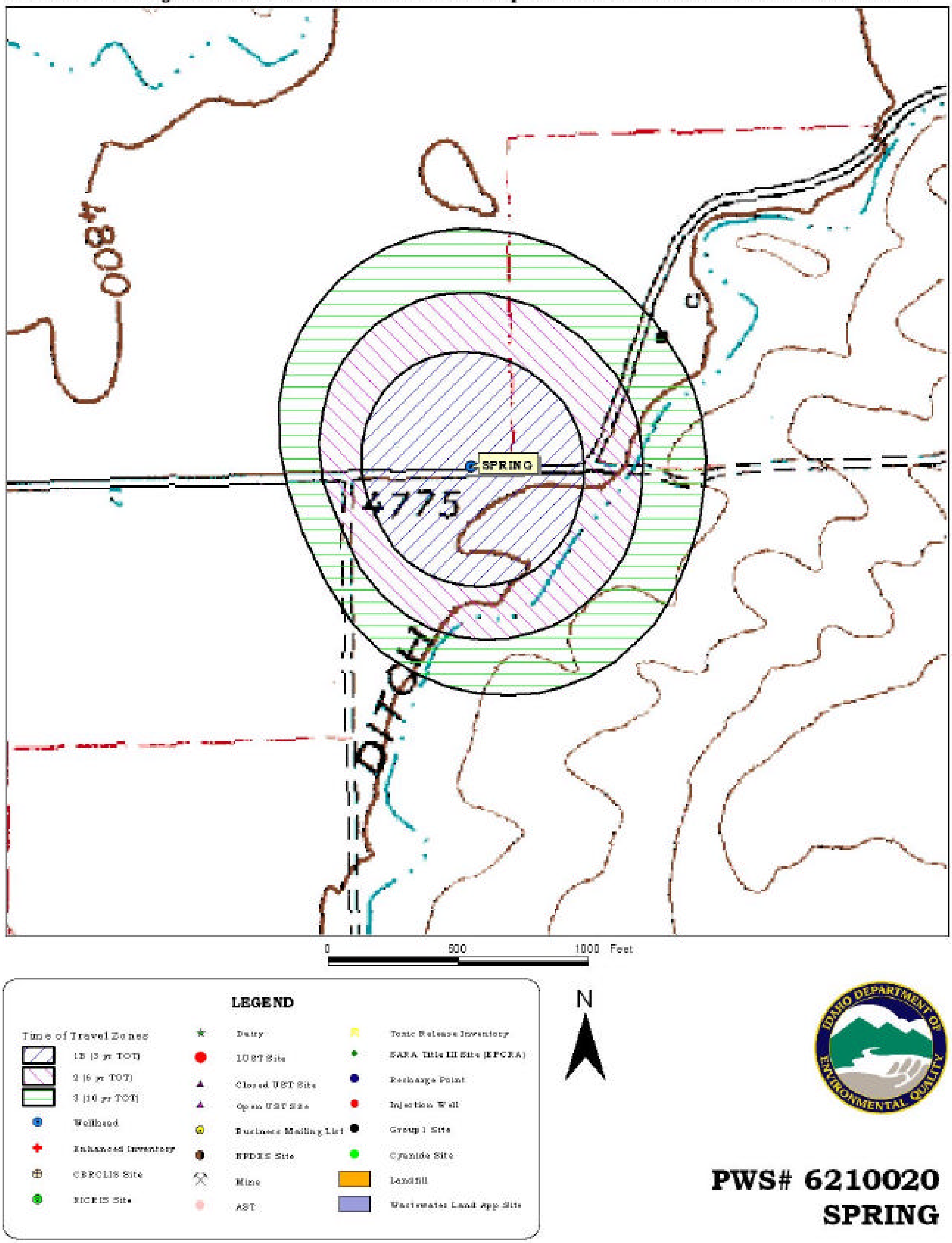


FIGURE 6. Whitney Nashville Water Works Delineation Map and Potential Contaminant Source Locations



Appendix B

Potential Contaminant Source Inventories
Whitney Nashville Water Works

Tables 3, 4, 5, 6, and 7

Table 3. Whitney Nashville Water Works, Well #1, Potential Contaminant Inventory

Site #	Source Description[1]	TOT Zone[2] (years)	Source of Information	Potential Contaminants[3]
1	Paint-Retail	0-3	Database Inventory	IOC, VOC, SOC
2	Former Dairy <=200 Cows	3-6	Database Inventory	IOC
3	Former Dairy <=200 Cows	3-6	Database Inventory	IOC
4	Former Dairy <=200 Cows	3-6	Database Inventory	IOC
5	LUST-Site Cleanup Completed, Impact: Unknown	6-10	Database Inventory	VOC, SOC
6	UST-Open	6-10	Database Inventory	VOC, SOC
7	UST-Closed	6-10	Database Inventory	VOC, SOC
8	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
9	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
10	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
11	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
12	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
13	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
14	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
15	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
16	Plastic & Plastic Products	6-10	Database Inventory	IOC, VOC, SOC
17	Roofing Contractors	6-10	Database Inventory	VOC, SOC
18	NPDES-Municipal Discharge	6-10	Database Inventory	IOC
	Highway 91	6-10	Database Inventory	IOC, VOC, SOC
	Johnson Reservoir	6-10	Database Inventory	IOC, VOC, SOC
	Septic System	0-3	Sanitary Survey	IOC, Microbials

[1] AST = above-ground storage tank, LUST = leaking underground storage tank, UST = underground storage tank, NPDES = national pollution discharge elimination system
[2] TOT = time-of-travel (in years) for a potential contaminant to reach the wellhead
[3] IOC = inorganic chemical, VOC = volatile organic chemical, SOC = synthetic organic chemical

Table 4. Whitney Nashville Water Works, Well #2, Potential Contaminant Inventory

Site #	Source Description[1]	TOT Zone[2] (years)	Source of Information	Potential Contaminants[3]
1	Paint-Retail	0-3	Database Inventory	IOC, VOC, SOC
2	Former Dairy <=200 Cows	3-6	Database Inventory	IOC
3	Former Dairy <=200 Cows	3-6	Database Inventory	IOC
4	Former Dairy <=200 Cows	3-6	Database Inventory	IOC
5	LUST-Site Cleanup Completed, Impact: Unknown	6-10	Database Inventory	VOC, SOC
6	UST-Open	6-10	Database Inventory	VOC, SOC
7	UST-Closed	6-10	Database Inventory	VOC, SOC
8	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
9	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
10	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
11	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
12	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
13	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
14	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
15	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
16	Plastic & Plastic Products	6-10	Database Inventory	IOC, VOC, SOC
17	Roofing Contractors	6-10	Database Inventory	VOC, SOC
18	NPDES-Municipal Discharge	6-10	Database Inventory	IOC
	Highway 91	6-10	Database Inventory	IOC, VOC, SOC
	Johnson Reservoir	6-10	Database Inventory	IOC, VOC, SOC

[1] AST = above-ground storage tank, LUST = leaking underground storage tank, UST = underground storage tank, NPDES = national pollution discharge elimination system
[2] TOT = time-of-travel (in years) for a potential contaminant to reach the wellhead
[3] IOC = inorganic chemical, VOC = volatile organic chemical, SOC = synthetic organic chemical

Table 5. Whitney Nashville Water Works, Well #3, Potential Contaminant Inventory

Site #	Source Description[1]	TOT Zone[2] (years)	Source of Information	Potential Contaminants[3]
1	Former Dairy <=200 Cows	3-6	Database Inventory	IOC
	Road	0-3	GIS Map	IOC, VOC, SOC, Microbials
	Road	3-6, 6-10	GIS Map	IOC, VOC, SOC
	Creek	0-3	GIS Map	IOC, VOC, SOC, Microbials
	Creek	3-6, 6-10	GIS Map	IOC, VOC, SOC

[2] TOT = time-of-travel (in years) for a potential contaminant to reach the wellhead
[3] IOC = inorganic chemical, VOC = volatile organic chemical, SOC = synthetic organic chemical

Table 6. Whitney Nashville Water Works, Pendleton Well, Potential Contaminant Inventory

Site #	Source Description[1]	TOT Zone[2] (years)	Source of Information	Potential Contaminants[3]
1	Former Dairy <=200 Cows	6-10	Database Inventory	IOC
	Creek	0-3	GIS Map	IOC, VOC, SOC, Microbials
	Creek	3-6, 6-10	GIS Map	IOC, VOC, SOC
	Road	3-6, 6-10	GIS Map	IOC, VOC, SOC

[2] TOT = time-of-travel (in years) for a potential contaminant to reach the wellhead
[3] IOC = inorganic chemical, VOC = volatile organic chemical, SOC = synthetic organic chemical

Table 7. Whitney Nashville Water Works, Spring, Potential Contaminant Inventory

Site #	Source Description[1]	TOT Zone[2] (years)	Source of Information	Potential Contaminants[3]
	Road	0-3	GIS Map	IOC, VOC, SOC, Microbials
	Road	3-6, 6-10	GIS Map	IOC, VOC, SOC
	Creek	0-3	GIS Map	IOC, VOC, SOC, Microbials
	Creek	3-6, 6-10	GIS Map	IOC, VOC, SOC

[2] TOT = time-of-travel (in years) for a potential contaminant to reach the wellhead

[3] IOC = inorganic chemical, VOC = volatile organic chemical, SOC = synthetic organic chemical

Appendix C

Whitney Nashville Water Works

Susceptibility Analysis Worksheets

Susceptibility Analysis Formulas

Formula for Well Sources
The final scores for the susceptibility analysis were determined using the following formulas:

1. VOC/SOC/IOC Final Score = Hydrologic Sensitivity + System Construction + (Potential Contaminant/Land Use x 0.2)

2. Microbial Final Score = Hydrologic Sensitivity + System Construction + (Potential Contaminant/Land Use x 0.375)

Final Susceptibility Scoring:
0 - 5 Low Susceptibility
6 - 12 Moderate Susceptibility
≥ 13 High Susceptibility

Formula for Spring Sources
The final spring scores for the susceptibility analysis were determined using the following formulas:

1. VOC/SOC/IOC/ Final Score = (Potential Contaminant/Land Use X 0.6) + System Construction

2. Microbial Final Score = (Potential Contaminant/Land Use X 1.125) + System Construction

Final Susceptibility Scoring:
0 - 7 Low Susceptibility
8 - 15 Moderate Susceptibility
≥ 16 High Susceptibility

Ground Water Susceptibility Report   Public Water System Name: WHITNEY NASHVILLE WATER WORKS   WELL #1 OLD
Public Water System Number 6210020   11/25/02 3:47:57 PM

1. System Construction		SCORE			
Drill Date	1960				
Driller Log Available	NO				
Sanitary Survey (if yes, indicate date of last survey)	YES	2000			
Well meets IDWR construction standards	NO	1			
Wellhead and surface seal maintained	NO	1			
Casing and annular seal extend to low permeability unit	NO	2			
Highest production 100 feet below static water level	NO	1			
Well located outside the 100 year flood plain	YES	0			
Total System Construction Score		5			
2. Hydrologic Sensitivity					
Soils are poorly to moderately drained	YES	0			
Vadose zone composed of gravel, fractured rock or unknown	YES	1			
Depth to first water > 300 feet	NO	1			
Aquitard present with > 50 feet cumulative thickness	NO	2			
Total Hydrologic Score		4			
3. Potential Contaminant / Land Use - ZONE 1A		IOC Score	VOC Score	SOC Score	Microbial Score
Land Use Zone 1A	IRRIGATED PASTURE	1	1	1	1
Farm chemical use high	NO	0	0	0	
IOC, VOC, SOC, or Microbial sources in Zone 1A	NO	NO	NO	NO	NO
Total Potential Contaminant Source/Land Use Score - Zone 1A		1	1	1	1
Potential Contaminant / Land Use - ZONE 1B					
Contaminant sources present (Number of Sources)	YES	2	2	2	1
(Score = # Sources X 2) 8 Points Maximum		4	4	4	2
Sources of Class II or III leacheable contaminants or	YES	6	2	2	
4 Points Maximum		4	2	2	
Zone 1B contains or intercepts a Group 1 Area	YES	2	0	0	0
Land use Zone 1B	Greater Than 50% Non-Irrigated Agricultural	2	2	2	2
Total Potential Contaminant Source / Land Use Score - Zone 1B		12	8	8	4
Potential Contaminant / Land Use - ZONE II					
Contaminant Sources Present	YES	2	0	0	
Sources of Class II or III leacheable contaminants or	YES	1	0	0	
Land Use Zone II	Greater Than 50% Non-Irrigated Agricultural	1	1	1	
Potential Contaminant Source / Land Use Score - Zone II		4	1	1	0
Potential Contaminant / Land Use - ZONE III					
Contaminant Source Present	YES	1	1	1	
Sources of Class II or III leacheable contaminants or	YES	1	1	1	
Is there irrigated agricultural lands that occupy > 50% of	YES	1	1	1	
Total Potential Contaminant Source / Land Use Score - Zone III		3	3	3	0
Cumulative Potential Contaminant / Land Use Score		20	13	13	5

4. Final Susceptibility Source Score	13	12	12	11
5. Final Well Ranking	High	Moderate	Moderate	Moderate

1. System Construction		SCORE
Drill Date	1962	
Driller Log Available	NO	
Sanitary Survey (if yes, indicate date of last survey)	YES	2000
Well meets IDWR construction standards	NO	1
Wellhead and surface seal maintained	NO	1
Casing and annular seal extend to low permeability unit	NO	2
Highest production 100 feet below static water level	NO	1
Well located outside the 100 year flood plain	YES	0
Total System Construction Score		5

2. Hydrologic Sensitivity		
Soils are poorly to moderately drained	YES	0
Vadose zone composed of gravel, fractured rock or unknown	YES	1
Depth to first water > 300 feet	NO	1
Aquitard present with > 50 feet cumulative thickness	NO	2
Total Hydrologic Score		4

3. Potential Contaminant / Land Use - ZONE 1A		IOC Score	VOC Score	SOC Score	Microbial Score
Land Use Zone 1A	IRRIGATED PASTURE	1	1	1	1
Farm chemical use high	NO	0	0	0	
IOC, VOC, SOC, or Microbial sources in Zone 1A	NO	YES	NO	NO	YES
Total Potential Contaminant Source/Land Use Score - Zone 1A		1	1	1	1
Potential Contaminant / Land Use - ZONE 1B					
Contaminant sources present (Number of Sources)	YES	1	1	1	0
(Score = # Sources X 2) 8 Points Maximum		2	2	2	0
Sources of Class II or III leacheable contaminants or	YES	5	1	1	
4 Points Maximum		4	1	1	
Zone 1B contains or intercepts a Group 1 Area	YES	2	0	0	0
Land use Zone 1B	Greater Than 50% Non-Irrigated Agricultural	2	2	2	2
Total Potential Contaminant Source / Land Use Score - Zone 1B		10	5	5	2
Potential Contaminant / Land Use - ZONE II					
Contaminant Sources Present	YES	2	0	0	
Sources of Class II or III leacheable contaminants or	YES	1	0	0	
Land Use Zone II	Greater Than 50% Non-Irrigated Agricultural	1	1	1	
Potential Contaminant Source / Land Use Score - Zone II		4	1	1	0
Potential Contaminant / Land Use - ZONE III					
Contaminant Source Present	YES	1	1	1	
Sources of Class II or III leacheable contaminants or	YES	1	1	1	
Is there irrigated agricultural lands that occupy > 50% of	YES	1	1	1	
Total Potential Contaminant Source / Land Use Score - Zone III		3	3	3	0
Cumulative Potential Contaminant / Land Use Score		18	10	10	3

4. Final Susceptibility Source Score	13	11	11	10
5. Final Well Ranking	High	Moderate	Moderate	High

1. System Construction		SCORE
Drill Date	1976	
Driller Log Available	NO	
Sanitary Survey (if yes, indicate date of last survey)	YES	2000
Well meets IDWR construction standards	NO	1
Wellhead and surface seal maintained	NO	1
Casing and annular seal extend to low permeability unit	NO	2
Highest production 100 feet below static water level	NO	1
Well located outside the 100 year flood plain	NO	1
Total System Construction Score		6

2. Hydrologic Sensitivity		
Soils are poorly to moderately drained	YES	0
Vadose zone composed of gravel, fractured rock or unknown	YES	1
Depth to first water > 300 feet	NO	1
Aquitard present with > 50 feet cumulative thickness	NO	2
Total Hydrologic Score		4

3. Potential Contaminant / Land Use - ZONE 1A		IOC Score	VOC Score	SOC Score	Microbial Score
Land Use Zone 1A	IRRIGATED PASTURE	1	1	1	1
Farm chemical use high	NO	0	0	0	
IOC, VOC, SOC, or Microbial sources in Zone 1A	YES	NO	NO	NO	NO
Total Potential Contaminant Source/Land Use Score - Zone 1A		1	1	1	1
Potential Contaminant / Land Use - ZONE 1B					
Contaminant sources present (Number of Sources)	YES	2	2	2	2
(Score = # Sources X 2) 8 Points Maximum		4	4	4	4
Sources of Class II or III leacheable contaminants or	YES	6	2	2	
4 Points Maximum		4	2	2	
Zone 1B contains or intercepts a Group 1 Area	NO	0	0	0	0
Land use Zone 1B	Greater Than 50% Non-Irrigated Agricultural	2	2	2	2
Total Potential Contaminant Source / Land Use Score - Zone 1B		10	8	8	6
Potential Contaminant / Land Use - ZONE II					
Contaminant Sources Present	YES	2	2	2	
Sources of Class II or III leacheable contaminants or	YES	1	1	1	
Land Use Zone II	Greater Than 50% Non-Irrigated Agricultural	1	1	1	
Potential Contaminant Source / Land Use Score - Zone II		4	4	4	0
Potential Contaminant / Land Use - ZONE III					
Contaminant Source Present	YES	1	1	1	
Sources of Class II or III leacheable contaminants or	YES	1	1	1	
Is there irrigated agricultural lands that occupy > 50% of	YES	1	1	1	
Total Potential Contaminant Source / Land Use Score - Zone III		3	3	3	0
Cumulative Potential Contaminant / Land Use Score		18	16	16	7

4. Final Susceptibility Source Score	14	13	13	13
5. Final Well Ranking	High	High	High	High

1. System Construction		SCORE			
Drill Date	1997				
Driller Log Available	NO				
Sanitary Survey (if yes, indicate date of last survey)	YES	2000			
Well meets IDWR construction standards	NO	1			
Wellhead and surface seal maintained	NO	1			
Casing and annular seal extend to low permeability unit	NO	2			
Highest production 100 feet below static water level	NO	1			
Well located outside the 100 year flood plain	YES	0			
Total System Construction Score		5			
2. Hydrologic Sensitivity					
Soils are poorly to moderately drained	YES	0			
Vadose zone composed of gravel, fractured rock or unknown	YES	1			
Depth to first water > 300 feet	NO	1			
Aquitard present with > 50 feet cumulative thickness	NO	2			
Total Hydrologic Score		4			
3. Potential Contaminant / Land Use - ZONE 1A		IOC Score	VOC Score	SOC Score	Microbial Score
Land Use Zone 1A	IRRIGATED PASTURE	1	1	1	1
Farm chemical use high	NO	0	0	0	
IOC, VOC, SOC, or Microbial sources in Zone 1A	NO	NO	NO	NO	NO
Total Potential Contaminant Source/Land Use Score - Zone 1A		1	1	1	1
Potential Contaminant / Land Use - ZONE 1B					
Contaminant sources present (Number of Sources)	YES	1	1	1	1
(Score = # Sources X 2) 8 Points Maximum		2	2	2	2
Sources of Class II or III leacheable contaminants or	YES	5	1	1	
4 Points Maximum		4	1	1	
Zone 1B contains or intercepts a Group 1 Area	NO	0	0	0	0
Land use Zone 1B	Greater Than 50% Non-Irrigated Agricultural	2	2	2	2
Total Potential Contaminant Source / Land Use Score - Zone 1B		8	5	5	4
Potential Contaminant / Land Use - ZONE II					
Contaminant Sources Present	YES	2	2	2	
Sources of Class II or III leacheable contaminants or	YES	1	1	1	
Land Use Zone II	Greater Than 50% Non-Irrigated Agricultural	1	1	1	
Potential Contaminant Source / Land Use Score - Zone II		4	4	4	0
Potential Contaminant / Land Use - ZONE III					
Contaminant Source Present	YES	1	1	1	
Sources of Class II or III leacheable contaminants or	YES	1	1	1	
Is there irrigated agricultural lands that occupy > 50% of	YES	1	1	1	
Total Potential Contaminant Source / Land Use Score - Zone III		3	3	3	0
Cumulative Potential Contaminant / Land Use Score		16	13	13	5

4. Final Susceptibility Source Score	12	11	11	11
5. Final Well Ranking	Moderate	Moderate	Moderate	Moderate

Spring Water Susceptibility Report   Public Water System Name: WHITNEY NASHVILLE WATER WORKS   SPRING
Public Water System Number 6210020   11/25/02 3:53:34 PM

1. System Construction

		SCORE
Intake structure properly constructed	NO	1
Is the water first collected from an underground source Yes=spring developed to collect water from beneath the ground; lower score No=water collected after it contacts the atmosphere or unknown; higher score	NO	2
Total System Construction Score		3

2. Potential Contaminant / Land Use - ZONE 1A

		IOC Score	VOC Score	SOC Score	Microbial Score
Land Use Zone 1A	IRRIGATED PASTURE	1	1	1	1
Farm chemical use high	NO	0	0	0	
IOC, VOC, SOC, or Microbial sources in Zone 1A	YES	NO	NO	NO	YES
Total Potential Contaminant Source/Land Use Score - Zone 1A		1	1	1	1
Potential Contaminant / Land Use - ZONE 1B					
Contaminant sources present (Number of Sources)	YES	2	2	2	2
(Score = # Sources X 2) 8 Points Maximum		4	4	4	4
Sources of Class II or III leacheable contaminants or	YES	6	2	2	
4 Points Maximum		4	2	2	
Zone 1B contains or intercepts a Group 1 Area	NO	0	0	0	0
Land use Zone 1B	Greater Than 50% Non-Irrigated Agricultural	2	2	2	2
Total Potential Contaminant Source / Land Use Score - Zone 1B		10	8	8	6
Potential Contaminant / Land Use - ZONE II					
Contaminant Sources Present	YES	2	2	2	
Sources of Class II or III leacheable contaminants or	YES	1	1	1	
Land Use Zone II	Greater Than 50% Non-Irrigated Agricultural	1	1	1	
Potential Contaminant Source / Land Use Score - Zone II		4	4	4	0
Potential Contaminant / Land Use - ZONE III					
Contaminant Source Present	YES	1	1	1	
Sources of Class II or III leacheable contaminants or	YES	1	1	1	
Is there irrigated agricultural lands that occupy > 50% of	YES	1	1	1	
Total Potential Contaminant Source / Land Use Score - Zone III		3	3	3	0
Cumulative Potential Contaminant / Land Use Score		18	16	16	7

	IOC	VOC	SOC	Microbial
4. Final Susceptibility Source Score	14	13	13	9
5. Final Spring Ranking	Moderate	Moderate	Moderate	High